

## December 2011 MSS/LPS/SPS Joint Subcommittee Meeting

# ABSTRACT SUBMITTAL FORM

The submission of an abstract is an agreement to complete a final paper for publication and attend the meeting to present this information. Complete all information requested in the author and co-author information sections; the first author listed will receive paper acceptance notices and all correspondence. Abstracts must be submitted electronically; submittal instructions are located in the call for papers. **The abstract deadline date is June 13, 2011.**

### ABSTRACT INFORMATION

Title: CFD Study of the Hydrocarbon Boost Low-Pressure Inducer and Kicker in the Presence of a Circumferential Groove

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## MANAGEMENT APPROVAL

The individual below certifies that the required resources are available to present this paper at the above subject JANNAF meeting.

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# ABSTRACT SUBMITTAL FORM

### Unclassified Abstract

*(250-300 words; do not include figures or tables)*

Results are presented of a computational fluid dynamics (CFD) study done in support of Marshall Space Flight Center's (MSFC) sub-scale water flow experiments of the Hydrocarbon Boost (HCB) Oxidizer Turbopump (OTP) being developed by the Air Force Research Laboratory (AFRL) and Aerojet. A circumferential groove may be added to the pump to reduce synchronous cavitation and subsequent bearing loads at a minimal performance cost. However, the energy may reappear as high order cavitation (HOC) that spans a relatively large frequency range. Thus, HOC may have implications for the full-scale OTP inducer in terms of reduced structural margin at higher mode frequencies. Simulations using the LOCI/Stream CFD program were conducted in order to explore the fluid dynamical impact of the groove on the low-pressure inducer and kicker. It was found that the circumferential groove has minimal head performance impact, but causes back-flowing high-swirl fluid to interact with the nearly-axial incoming fluid just above the inducer blades. The high-shear interface between the fluids is Kelvin-Helmholtz unstable, resulting in trains of low pressure regions or 'pearls' forming near the upstream edge of the groove. When the static pressure in these regions becomes low enough and they get cut by the blade leading edge, HOC is thought to occur. Although further work is required, the numerical models indicate that HOC will occur in the runbox of the AFRL/Aerojet HCB OTP. Comparisons to the ongoing water flow experiments will be discussed, as well as possible designs that may mitigate HOC while continuing to reduce synchronous cavitation.